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TI Manufacture of copper alloy thin **wire** having high strength and fatigue resistance
IN Fujiwara, Hidemichi; Yamazaki, Akira; Osada, Katsuki
PA Furukawa Electric Co., Ltd., Japan
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AB Cu alloy thin **wire** having diam. .ltoreq.50 .mu.m is from Cu-(1.0-4.5%)Ag alloy, Cu-(0.2-1.5%)Cr alloy, Cu-(0.1-0.3%)Zr alloy, Cu-(0.2-1.5)Cr-(0.1-0.3%)Zr alloy or Cu-(0.3-4.0%)Ti alloy by cold drawing at .ltoreq.99.999% draft optionally with intermediate annealing. When intermediate annealing is carried out, the cold draft between intermediate annealing processes is .ltoreq.99.999% and the cold draft after the final annealing is 80-99%.

PATENT ABSTRACTS OF JAPAN

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(54) PRODUCTION OF COPPER ALLOY EXTRA FINE WIRE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a method for producing a copper alloy extra fine wire of ≤50 μm in wire diameter excellent in wire drawability, strength, fatigue resistance.

SOLUTION: This is a method for producing a copper alloy extra fine thin wire of ≤50 μm in wire diameter in which a copper alloy soft stock contg. phases such as crystallized products (Cu-1.0 to 4.5 wt.% Ag alloy, Cu-0.2 to 1.5 wt.% Cr allay, Cu-0.1 to 0.3 wt.% Zr allay, Cu 0.2 to 1.5 wt.% Cr-0.1 to 0.3 wt.% Zr alloy or Cu-0.3 to 4.0 wt.% Ti alloy) is cold worked and is subjected to process annealing necessary, and in which the cold working ratio from the copper alloy soft stock is regulated to ≤99.99%, the cold working ratio till the following process annealing after the process annealing other than the final process annealing is regulated to ≤99.999%, and the cold working ratio after the final process annealing is regulated to 80 to 99%.

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CLAIMS

[Claim(s)]
[Claim 1] Cold-work the copper alloy elasticity material containing unusual appearances, such as a crystallization object, and give intermediate annealing if needed. When it is the manufacture method of the copper alloy extra fine wire of 50 micrometers or less of wire sizes, the rate of cold working from the aforementioned copper alloy elasticity material is made into 99.999% or less and it gives intermediate annealing It is the manufacture method of the copper alloy extra fine wire which makes the rate of cold working between intermediate annealing 99.999% or less, and is characterized by making the rate of cold working after the last intermediate annealing 80 - 99%.
[Claim 2] The manufacture method of the copper alloy extra fine wire according to claim 1 characterized by the copper alloy elasticity material containing unusual appearances, such as a crystallization object, being a Cu-1.0-4.5wt%Ag alloy, a Cu-0.2-1.5wt%Cr alloy, a Cu-0.1-0.3wt%Zr alloy, a Cu-0.2-1.5wt%Cr-0.1-0.3wt%Zr alloy, or a Cu-0.3-4.0wt%Ti alloy.
[Claim 3] The manufacture method of the copper alloy extra fine wire according to claim 1 or 2 characterized by holding intermediate annealing for [1 second -] 30 minutes, and giving it at 300-550 degrees C.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention is excellent in wire drawing nature, intensity, a defatigation-proof property, etc., and relates to the manufacture method of the copper alloy extra fine wire of 50 micrometers or less of wire sizes suitable for especially the coil.
[0002]
[Description of the Prior Art] Wire drawing nature, intensity, a defatigation-proof property, etc. are required of the copper alloy extra fine wire used for a coil etc. Since especially wire drawing nature influences cost greatly, it is important. The tough pitch copper, the copper alloy containing Sn, the copper alloy containing 0.2% or less of Ag, etc. have been conventionally used for such a copper alloy extra fine wire. And with the miniaturization of a pocket device in recent years, 20 micrometers is asked for thinning from 50 micrometers or less and 30 more micrometers at the extra fine wire for coils, and greater importance is increasingly attached to intensity, a defatigation-proof property, etc. than to before.
[0003]
[Problem(s) to be Solved by the Invention] However, if the conventional copper alloy extra fine wire became a diameter 50 micrometers or less, it will become easy to disconnect it, and the problem has produced it for productivity. Then, by selecting processing conditions, this invention person etc. searched for various copper alloys which are excellent in cold-working nature, and it finds out that thinning can be carried out to a diameter 20 micrometers or less, and a copper alloy, a Cu-Cr alloy, etc. which contain Ag 1% or more advance research further, and came to complete this invention. The purpose of this invention is for the wire size which is excellent in wire drawing nature, intensity, a defatigation-proof property, etc. to offer the manufacture method of a copper alloy extra fine wire 50 micrometers or less.
[0004]
[Means for Solving the Problem] Invention according to claim 1 cold-works the copper alloy elasticity material containing unusual appearances, such as a crystallization object. When it is the manufacture method of the copper alloy extra fine wire of 50 micrometers or less of wire sizes which gives intermediate annealing if needed, the rate of cold working from the aforementioned copper alloy elasticity material is made into 99.999% or less and it gives intermediate annealing It is the manufacture method of the copper alloy extra fine wire which makes the rate of cold working between intermediate annealing 99.999% or less, and is characterized by making the rate of cold working after the last intermediate annealing 80 - 99%.
[0005] Invention according to claim 2 is the manufacture method of the copper alloy extra fine wire according to claim 1 characterized by the copper alloy elasticity material containing unusual appearances, such as a crystallization object, being a Cu-1.0-4.5wt%Ag alloy, a Cu-0.2-1.5wt%Cr alloy, a Cu-0.1-0.3wt%Zr alloy, a Cu-0.2-1.5wt%Cr-0.1-0.3wt% Zr alloy, or a Cu-0.3-4.0wt%Ti alloy.
[0006] Invention according to claim 3 is the manufacture method of the copper alloy extra fine wire according to claim 1 or 2 characterized by holding intermediate annealing for [1 second -] 30 minutes, and giving it at 300-550 degrees C.
[0007]
[Embodiments of the Invention] this invention is the method of cold-working the copper alloy elasticity material containing unusual appearances, such as a crystallization object, by predetermined working ratio, giving intermediate annealing if needed, and processing it into the extra fine wire of 50 micrometers or less of wire sizes. A sludge etc. is contained in unusual appearances, such as the aforementioned crystallization object. As a copper alloy elasticity material, minor diameter ingots, such as a Cu-1.0-4.5wt%Ag alloy, a Cu-0.2-1.5wt%Cr alloy, a Cu-0.1-0.3wt%Zr

alloy, a Cu-0.2-1.5wt%Cr-0.1-0.3wt%Zr alloy, or a Cu-0.3-4.0wt%Ti alloy, hot rolling material (rough drawing wire), hot-extrusion material, an annealed material, etc. are mentioned. The aforementioned copper alloy elasticity material is processed between the colds by rolling, grooved-roll rolling, drawing-out processing, wire drawing, etc., and is processed into the extra fine wire of a request configuration.

[0008] Cold working is distributing minutely in the shape of a staple fiber, respectively, and as for these distribution object, in each aforementioned copper alloy, unusual appearances (Ag particle, Cr particle, a Zr-Cu compound particle, Ti-Cu compound particle, etc.), such as a crystallization object of an alloy element, achieve the operation which distributes minutely and uniformly the transposition cell formed in a copper alloy matrix in connection with cold working, and raise the cold-working nature of each aforementioned copper alloy to it. Since there are few aforementioned crystallization objects etc. under at a minimum, when no reasons for a convention of the amount of alloy elements of each aforementioned copper alloy are distributed minutely [a transposition cell] and uniformly but exceed an upper limit, a crystallization object etc. is for turning and causing an open circuit big and rough remarkably.

[0009] the aforementioned crystallization object is detailed in a transposition cell as mentioned above -- and although it equalizes, on the other hand, if cold working progresses, a transposition cell will turn minutely remarkably, pinning of the transposition is carried out there, and an open circuit becomes easy to occur

[0010] Then, in this invention, when the rate of cold working from the aforementioned copper alloy elasticity material exceeds 99.999%, intermediate annealing is given and an open circuit is prevented. By intermediate annealing, transposition moves in heat activity, a transposition cell turns big and rough, and cold-working nature is improved. The rate of cold working between intermediate annealing in the case of giving intermediate annealing two or more times is made 99.999% or less like the rate of cold working from the aforementioned copper alloy elasticity material. However, the rate of cold working after the last intermediate annealing is specified to 80 - 99%. When the intensity which needs the reason for a copper alloy extra fine wire at less than 80% is not obtained but it exceeds 99%, a transposition cell is for turning and becoming easy to disconnect in the cases, such as coiling, minutely. In addition, a Cu-Cr alloy, a Cu-Zr alloy, and a Cu-Ti alloy can raise intensity further by giving an aging treatment after cold working.

[0011] As mentioned above, if a transposition cell carries out intermediate annealing of the cold-working wire rod formed minutely, transposition will move in heat activity, a transposition cell will turn big and rough, and cold-working nature will be improved. When, as for the aforementioned intermediate annealing, the effect exceeds 550 degrees C by fully not obtaining an annealing temperature at less than 300 degrees C, the on-the-strength fall by annealing is large, and henceforth, even if it cold-works, sufficient intensity is no longer obtained. Moreover, if the time for annealing time moving in [transposition] heat activity in less than 1 second runs short and it exceeds 30 minutes, the effect of intermediate annealing will be saturated and it will become disadvantageous in energy cost. Therefore, as for intermediate annealing, it is desirable to give for [1 second -] 30 minutes at 300-550 degrees C.

[0012]

[Example] An example explains this invention in detail below.

(Example 1) The horizontal-type continuous casting machine cast the various copper alloys of the composition in this invention convention to the cylindrical ingot of the diameter of 10.8mm, this ingot was peeled in the diameter of 10mm, wire drawing of the ingot after this peeling was carried out, and it considered as the wire rod of the diameter of 0.10mm, or the diameter of 0.05mm. Subsequently, annealing between ** was given to each aforementioned wire rod on the conditions held for 30 seconds at 300-550 degrees C, wire drawing was again carried out to it after that, and the copper alloy extra fine wire of the diameter of 20 micrometer (0.02mm) was manufactured.

[0013] (Example 2) The horizontal-type continuous casting machine cast the various copper alloys of the composition in this invention convention to the cylindrical ingot of the diameter of 10.8mm, this ingot was peeled in the diameter of 10mm, wire drawing of the ingot after this peeling was carried out, and it considered as the wire rod of the diameter of 0.10mm, or the diameter of 0.05mm. Subsequently, annealing between ** was given to each aforementioned wire rod on the conditions held for 30 seconds at 580 degrees C or 280 degrees C, wire drawing was again carried out to it after that, and the copper alloy extra fine wire of the diameter of 20 micrometer was manufactured.

[0014] (Example 1 of comparison) The horizontal-type continuous casting machine cast the various copper alloys of the composition in this invention convention to the cylindrical ingot of the diameter of 10.8mm, this ingot was peeled in the diameter of 10mm, wire drawing of the ingot after this peeling was carried out, and it considered as the wire rod of the diameter of 0.30mm, or the diameter of 0.03mm. Subsequently, annealing between ** was given to each aforementioned wire rod on the conditions held for 30 seconds at 400 degrees C, wire drawing was again carried out to it after that, and the copper alloy extra fine wire of the diameter of 20 micrometer was manufactured.

[0015] (Example 2 of comparison) The horizontal-type continuous casting machine cast the various copper alloys of the composition in this invention convention to the cylindrical ingot of the diameter of 10.8mm, this ingot was peeled in the diameter of 10mm, wire drawing of the ingot after this peeling was carried out, and the copper alloy extra fine

wire of the diameter of 20 micrometer was manufactured. Annealing between ** was not given the middle.
[0016] (Example 3 of comparison) The horizontal-type continuous casting machine cast the copper alloy of composition this invention convention outside to the cylindrical ingot of the diameter of 10.8mm, this ingot was peeled in the diameter of 10mm, wire drawing of the ingot after this peeling was carried out, and it considered as the wire rod of the diameter of 0.10mm, or the diameter of 0.05mm. Subsequently, annealing between ** was given to each aforementioned wire rod on the conditions held for 30 seconds at 400 degrees C, wire drawing was again carried out to it after that, and the copper alloy extra fine wire of the diameter of 20 micrometer was manufactured.
[0017] Tensile strength, a defatigation fracture property, and wire drawing nature were investigated about each copper alloy extra fine wire obtained in examples 1 and 2 and the examples 1-3 of comparison. A defatigation fracture property is 2 200Ns/mm. It expressed with the number of times to the fracture when repeating bending 90 degrees, carrying out the load of the stress. One round trip was counted with 1 time. Wire drawing nature was expressed with the value which **(ed) the amount of wire drawings by the number of times of fracture when carrying out a continuation wire drawing to 20 micrometers from 30 micrometers. The analysis value of alloy composition is shown in Table 1, and results of an investigation are shown in Tables 2-5, respectively. A drawing condition and annealing conditions were written together in Tables 2-5.
[0018]
[Table 1]

	合金	Ag	Cr	Zr	Ti		合金	Ag	Cr	Zr	Ti
本発明規定内組成合金	1	1.0	--	--	--	本発明規定外組成合金	10	0.2	--	--	--
	2	2.0	--	--	--		11	--	0.15	--	--
	3	4.0	--	--	--		12	--	--	0.05	--
	4	--	0.3	--	--		13	--	0.04	0.03	--
	5	--	1.3	--	--		14	--	--	--	0.1
	6	--	--	0.25	-						
	7	--	0.28	0.22	--						
	8	--	--	--	0.5						
	9	--	--	--	3.8						

(注) 単位wt%。

[0019]
[Table 2]

分類	試料	合金	焼鈍サイズ # mm	焼鈍温度 ℃	引張強さ N／mm²	疲労破断 回数×10⁶	伸線性 kg／1断線
本発明例	1	1	0.1	400	840	17	3.9
	2		0.05	400	800	10	4.1
	3	2	0.1	550	880	23	3.5
	4		0.1	400	950	40	3.8
	5		0.1	300	970	42	3.6
	6		0.05	400	900	35	4.2
	7	3	0.1	400	1010	45	3.6
	8		0.05	400	960	41	3.4
	9	4	0.1	400	890	24	3.5
	10		0.05	400	850	18	4.0
	11	5	0.1	400	960	41	3.5
	12		0.05	400	920	37	3.7

(Note) Diameter of diameter-(96%) ->of diameter-(99.99%)--> of #10mm 0.1mm 0.02mm Diameter of diameter [of diameter / of 10mm /-(99.9975%) ->0.05mm]-(84%) ->0.02mm Sample No.1-12 are an example 1.

[0020]

[Table 3]

分類	試料	合金	焼鈍線径 # mm	焼鈍温度 ℃	引張強さ N／mm²	疲労破断 回数×10⁶	伸線性 kg／1断線
本発明例	13	6	0.1	400	850	15	3.8
	14		0.05	400	800	10	4.1
	15	7	0.1	400	940	35	3.5
	16		0.05	400	900	28	3.8
	17	8	0.1	400	1100	50	3.1
	18		0.05	400	1050	44	3.3
	19	9	0.1	400	1210	57	3.0
	20		0.05	400	1140	53	3.1
	21	2	0.1	570	840	14	3.7
	22		0.1	280	990	43	3.4
	23	3	0.1	570	910	29	3.6
	24		0.1	280	1060	45	3.3

(Note) Diameter of #10mm -- (99.99%) Diameter of -> 0.1mm (96%) Diameter of ->0.02mm Diameter of diameter [of

10mm]-(99.9975%) ->0.05mm (84%) Diameter of ->0.02mm Sample No.13-20 are an example 1 and sample No.21-24 are an example 2.

[0021]

[Table 4]

分類	試料	合金	焼鈍線径 # mm	焼鈍温度 ℃	引張強さ N／mm²	疲労破断回数×10⁶	伸線性 kg／1 断線
比較例1	25	2	0.3	400	980	33	1.3
	26		0.03	400	720	2.1	2.8
	27	3	0.3	400	1010	38	1.5
	28		0.03	400	760	3.3	2.6
	29	4	0.3	400	910	18	1.1
	30		0.03	400	680	1.1	2.2
	31	6	0.3	400	870	15	0.8
	32		0.03	400	620	0.9	1.4
	33	7	0.3	400	960	28	0.7
	34		0.03	400	730	1.8	1.6
	35	8	0.3	400	1070	39	1.9
	36		0.03	400	790	3.8	2.7

(Note) Diameter of diameter-(99.56%) ->of diameter-(99.91%)--> of #10mm 0.3mm 0.02mm Diameter of diameter [of diameter / of 10mm /-(99.9991%) ->0.03mm]-(55.56%) ->0.02mm. [0022]

[Table 5]

分類	試料	合金	焼鈍サイズ # mm 径	焼鈍温度 ℃	引張強さ N／mm²	疲労破断回数×10⁶	伸線性 kg／1断線
比較例2	37	2	中間焼鈍なし		1050	34	0.34
	38	3	〃		1060	36	0.41
	39	4	〃		820	16	0.22
	40	6	〃		820	14	0.32
	41	7	〃		840	18	0.50
	42	8	〃		1010	33	0 37
比較例3	43	10	0.1	400	920	19	0.33
	44		0.05	400	870	14	0.52
	45	11	0.1	400	650	1.0	2.83
	46		0.05	400	620	0.8	2.52
	47	12	0.1	400	720	3.5	1.4
	48		0.05	400	620	1.1	1.6
	49	13	0.1	400	810	9.5	1.7
	50		0.05	400	780	3.3	1.2
	51	14	0.1	400	950	18	0.52
	52		0.05	400	920	21	0.44

(Note) Diameter of #10mm -(99.9996%)-------- Diameter of ->0.02mm (with no intermediate annealing) Diameter of 10mm -- (99.99%) Diameter of -> 0.1mm (96%) Diameter of ->0.02mm Diameter of diameter [of 10mm]-(99.9975%) ->0.05mm (84%) Diameter of ->0.02mm. [0023] In having wire drawing nature 3.0kg [per one open circuit] or more, each sample No.1-24 of the example of this invention is excellent also in intensity and the defatigation-proof property, so that more clearly than Tables 2-5 (two or more [800Ns //mm] tensile strength and the number of times of defatigation fracture more than 107 times). On the other hand, example 1 of comparison No.25-36 and example 2 of comparison Since the rate of cold working separated from the convention of this invention, No.37-42 are the example 3 of comparison. Since No.43-52 had few amounts of alloy elements, they were that to which wire drawing nature falls and neither is suitable for practical use. Moreover, thing to which the rate of cold working after the last intermediate annealing exceeded 99% (No.25, 27, 29, 31, 33, 35) The waist is weakly inferior to coiling nature (it does not display), and the aforementioned rate of cold working is less than 80% of thing (No.26, 28, 30, 32, 34, 36). It was inferior to tensile strength and the defatigation fracture property. No.45-50 were inferior in at least one sort of tensile strength and a defatigation fracture property among those for which the amount of alloy elements was insufficient.

[0024]

[Effect of the Invention] As stated above, moreover, by this invention, since the crystallization object contained there distributes a transposition cell minutely and uniformly, the copper alloy used by this invention is excellent in cold-working nature, and it is predetermined conditions about the aforementioned copper alloy, and since it cold-works putting in annealing if needed, it can manufacture an extra fine wire 50 micrometers or less good. The extra fine wire furthermore obtained in this invention is excellent also in intensity and a defatigation-proof property. Therefore, this invention is applied to manufacture of a coil etc. and does a remarkable effect so.

[Translation done.]

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TECHNICAL FIELD

[The technical field to which invention belongs] this invention is excellent in wire drawing nature, intensity, a fatigue-proof property, etc., and relates to the manufacture method of the copper alloy extra fine wire of 50 micrometers or less of wire sizes suitable for especially the coil.

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PRIOR ART

[Description of the Prior Art] Wire drawing nature, intensity, a fatigue-proof property, etc. are required of the copper alloy extra fine wire used for a coil etc. Since especially wire drawing nature influences cost greatly, it is important. The tough pitch copper, the copper alloy containing Sn, the copper alloy containing 0.2% or less of Ag, etc. have been conventionally used for such a copper alloy extra fine wire. And with the miniaturization of a pocket device in recent years, 20 micrometers is asked for thinning from 50 micrometers or less and 30 more micrometers at the extra fine wire for coils, and greater importance is increasingly attached to intensity, a fatigue-proof property, etc. than to before.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] As stated above, moreover, by this invention, since the crystallization object contained there distributes a transposition cell minutely and uniformly, the copper alloy used by this invention is excellent in cold-working nature, and it is predetermined conditions about the aforementioned copper alloy, and since it cold-works putting in annealing if needed, it can manufacture an extra fine wire 50 micrometers or less good. The extra fine wire furthermore obtained in this invention is excellent also in intensity and a defatigation-proof property. Therefore, this invention is applied to manufacture of a coil etc. and does a remarkable effect so.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, if the conventional copper alloy extra fine wire became a diameter 50 micrometers or less, it will become easy to disconnect it, and the problem has produced it for productivity. Then, by selecting processing conditions, this invention person etc. searched for various copper alloys which are excellent in cold-working nature, and it finds out that thinning can be carried out to a diameter 20 micrometers or less, and a copper alloy, a Cu-Cr alloy, etc. which contain Ag 1% or more advance research further, and came to complete this invention. The purpose of this invention is for the wire size which is excellent in wire drawing nature, intensity, a fatigue-proof property, etc. to offer the manufacture method of a copper alloy extra fine wire 50 micrometers or less.

[Translation done.]

MEANS

[Means for Solving the Problem] Invention according to claim 1 cold-works the copper alloy elasticity material containing unusual appearances, such as a crystallization object. When it is the manufacture method of the copper alloy extra fine wire of 50 micrometers or less of wire sizes which gives intermediate annealing if needed, the rate of cold working from the aforementioned copper alloy elasticity material is made into 99.999% or less and it gives intermediate annealing It is the manufacture method of the copper alloy extra fine wire which makes the rate of cold working between intermediate annealing 99.999% or less, and is characterized by making the rate of cold working after the last intermediate annealing 80 - 99%.
[0005] Invention according to claim 2 is the manufacture method of the copper alloy extra fine wire according to claim 1 characterized by the copper alloy elasticity material containing unusual appearances, such as a crystallization object, being a Cu-1.0-4.5wt%Ag alloy, a Cu-0.2-1.5wt%Cr alloy, a Cu-0.1-0.3wt%Zr alloy, a Cu-0.2-1.5wt%Cr-0.1-0.3wt% Zr alloy, or a Cu-0.3-4.0wt%Ti alloy.
[0006] Invention according to claim 3 is the manufacture method of the copper alloy extra fine wire according to claim 1 or 2 characterized by holding intermediate annealing for [1 second -] 30 minutes, and giving it at 300-550 degrees C.
[0007]
[Embodiments of the Invention] this invention is the method of cold-working the copper alloy elasticity material containing unusual appearances, such as a crystallization object, by predetermined working ratio, giving intermediate annealing if needed, and processing it into the extra fine wire of 50 micrometers or less of wire sizes. A sludge etc. is contained in unusual appearances, such as the aforementioned crystallization object. As a copper alloy elasticity material, minor diameter ingots, such as a Cu-1.0-4.5wt%Ag alloy, a Cu-0.2-1.5wt%Cr alloy, a Cu-0.1-0.3wt%Zr alloy, a Cu-0.2-1.5wt%Cr-0.1-0.3wt%Zr alloy, or a Cu-0.3-4.0wt%Ti alloy, hot rolling material (rough drawing wire), hot-extrusion material, an annealed material, etc. are mentioned. The aforementioned copper alloy elasticity material is processed between the colds by rolling, grooved-roll rolling, drawing-out processing, wire drawing, etc., and is processed into the extra fine wire of a request configuration.
[0008] Cold working is distributing minutely in the shape of a staple fiber, respectively, and as for these distribution object, in each aforementioned copper alloy, unusual appearances (Ag particle, Cr particle, a Zr-Cu compound particle, Ti-Cu compound particle, etc.), such as a crystallization object of an alloy element, achieve the operation which distributes minutely and uniformly the dislocation cell formed in a copper alloy matrix in connection with cold working, and raise the cold-working nature of each aforementioned copper alloy to it. Since there are few aforementioned crystallization objects etc. under at a minimum, when no reasons for a convention of the amount of alloy elements of each aforementioned copper alloy are distributed minutely [a dislocation cell] and uniformly but exceed an upper limit, a crystallization object etc. is for turning and causing an open circuit big and rough remarkably.
[0009] the aforementioned crystallization object is detailed in a dislocation cell as mentioned above -- and although it equalizes, on the other hand, if cold working progresses, a dislocation cell will turn minutely remarkably, pinning of the dislocation is carried out there, and an open circuit becomes easy to occur
[0010] Then, in this invention, when the rate of cold working from the aforementioned copper alloy elasticity material exceeds 99.999%, intermediate annealing is given and an open circuit is prevented. By intermediate annealing, dislocation moves in heat activity, a dislocation cell turns big and rough, and cold-working nature is improved. The rate of cold working between intermediate annealing in the case of giving intermediate annealing two or more times is made 99.999% or less like the rate of cold working from the aforementioned copper alloy elasticity material. However, the rate of cold working after the last intermediate annealing is specified to 80 - 99%. When the intensity which needs the reason for a copper alloy extra fine wire at less than 80% is not obtained but it exceeds 99%, a dislocation cell is for turning and becoming easy to disconnect in the cases, such as coiling, minutely. In addition, a Cu-Cr alloy, a Cu-Zr

alloy, and a Cu-Ti alloy can raise intensity further by giving an aging treatment after cold working.

[0011] As mentioned above, if a dislocation cell carries out intermediate annealing of the cold-working wire rod formed minutely, dislocation will move in heat activity, a dislocation cell will turn big and rough, and cold-working nature will be improved. When, as for the aforementioned intermediate annealing, the effect exceeds 550 degrees C by fully not obtaining an annealing temperature at less than 300 degrees C, the on-the-strength fall by annealing is large, and henceforth, even if it cold-works, sufficient intensity is no longer obtained. Moreover, if the time for annealing time moving in [dislocation] heat activity in less than 1 second runs short and it exceeds 30 minutes, the effect of intermediate annealing will be saturated and it will become disadvantageous in energy cost. Therefore, as for intermediate annealing, it is desirable to give for [1 second -] 30 minutes at 300-550 degrees C.

[Translation done.]

EXAMPLE

[Example] An example explains this invention in detail below.
(Example 1) The horizontal-type continuous casting machine cast the various copper alloys of the composition in this invention convention to the cylindrical ingot of the diameter of 10.8mm, this ingot was peeled in the diameter of 10mm, wire drawing of the ingot after this peeling was carried out, and it considered as the wire rod of the diameter of 0.10mm, or the diameter of 0.05mm. Subsequently, annealing between ** was given to each aforementioned wire rod on the conditions held for 30 seconds at 300-550 degrees C, wire drawing was again carried out to it after that, and the copper alloy extra fine wire of the diameter of 20 micrometer (0.02mm) was manufactured.
[0013] (Example 2) The horizontal-type continuous casting machine cast the various copper alloys of the composition in this invention convention to the cylindrical ingot of the diameter of 10.8mm, this ingot was peeled in the diameter of 10mm, wire drawing of the ingot after this peeling was carried out, and it considered as the wire rod of the diameter of 0.10mm, or the diameter of 0.05mm. Subsequently, annealing between ** was given to each aforementioned wire rod on the conditions held for 30 seconds at 580 degrees C or 280 degrees C, wire drawing was again carried out to it after that, and the copper alloy extra fine wire of the diameter of 20 micrometer was manufactured.
[0014] (Example 1 of comparison) The horizontal-type continuous casting machine cast the various copper alloys of the composition in this invention convention to the cylindrical ingot of the diameter of 10.8mm, this ingot was peeled in the diameter of 10mm, wire drawing of the ingot after this peeling was carried out, and it considered as the wire rod of the diameter of 0.30mm, or the diameter of 0.03mm. Subsequently, annealing between ** was given to each aforementioned wire rod on the conditions held for 30 seconds at 400 degrees C, wire drawing was again carried out to it after that, and the copper alloy extra fine wire of the diameter of 20 micrometer was manufactured.
[0015] (Example 2 of comparison) The horizontal-type continuous casting machine cast the various copper alloys of the composition in this invention convention to the cylindrical ingot of the diameter of 10.8mm, this ingot was peeled in the diameter of 10mm, wire drawing of the ingot after this peeling was carried out, and the copper alloy extra fine wire of the diameter of 20 micrometer was manufactured. Annealing between ** was not given the middle.
[0016] (Example 3 of comparison) The horizontal-type continuous casting machine cast the copper alloy of composition this invention convention outside to the cylindrical ingot of the diameter of 10.8mm, this ingot was peeled in the diameter of 10mm, wire drawing of the ingot after this peeling was carried out, and it considered as the wire rod of the diameter of 0.10mm, or the diameter of 0.05mm. Subsequently, annealing between ** was given to each aforementioned wire rod on the conditions held for 30 seconds at 400 degrees C, wire drawing was again carried out to it after that, and the copper alloy extra fine wire of the diameter of 20 micrometer was manufactured.
[0017] Tensile strength, a fatigue fracture property, and wire drawing nature were investigated about each copper alloy extra fine wire obtained in examples 1 and 2 and the examples 1-3 of comparison. A fatigue fracture property is 2 200Ns/mm. It expressed with the number of times to the fracture when repeating bending 90 degrees, carrying out the load of the stress. One round trip was counted with 1 time. Wire drawing nature was expressed with the value which ** (ed) the amount of wire drawings by the number of times of fracture when carrying out a continuation wire drawing to 20 micrometers from 30 micrometers. The analysis value of alloy composition is shown in Table 1, and results of an investigation are shown in Tables 2-5, respectively. A drawing condition and annealing conditions were written together in Tables 2-5.
[0018]
[Table 1]

	合金	Ag	Cr	Zr	Ti		合金	Ag	Cr	Zr	Ti
本発明規定内組成合金	1	1.0	－－	－－	－－	本発明規定外組成合金	10	0.2	－－	－－	－－
	2	2.0	－－	－－	－－		11	－－	0.15	－－	－－
	3	4.0	－－	－－	－－		12	－－	－－	0.05	－－
	4	－－	0.3	－－	－－		13	－－	0.04	0.03	－－
	5	－－	1.3	－－	－－		14	－－	－－	－－	0.1
	6	－－	－－	0.25	－						
	7	－－	0.28	0.22	－－						
	8	－－	－－	－－	0.5						
	9	－－	－－	－－	3.8						

（注）単位wt%。

[0019]
[Table 2]

分類	試料	合金	焼鈍サイズ # mm	焼鈍温度 ℃	引張強さ N／mm²	疲労破断回数×10⁶	伸線性 kg／1断線
本発明例	1	1	0.1	400	840	17	3.9
	2		0.05	400	800	10	4.1
	3	2	0.1	550	880	23	3.5
	4		0.1	400	950	40	3.8
	5		0.1	300	970	42	3.6
	6		0.05	400	900	35	4.2
	7	3	0.1	400	1010	45	3.6
	8		0.05	400	960	41	3.4
	9	4	0.1	400	890	24	3.5
	10		0.05	400	850	18	4.0
	11	5	0.1	400	960	41	3.5
	12		0.05	400	920	37	3.7

(Note) Diameter of diameter-(96%) ->of diameter-(99.99%)--> of #10mm 0.1mm 0.02mm Diameter of diameter [of diameter / of 10mm /-(99.9975%) ->0.05mm]-(84%) ->0.02mm Sample No.1-12 are an example 1.
[0020]
[Table 3]

分類	試料	合金	焼鈍線径 # mm	焼鈍温度 ℃	引張強さ N／mm²	疲労破断回数×10⁶	伸線性 kg／1断線
本発明例	13 14	6	0．1 0．05	400 400	850 800	15 10	3．8 4．1
	15 16	7	0．1 0．05	400 400	940 900	35 28	3．5 3．8
	17 18	8	0．1 0．05	400 400	1100 1050	50 44	3．1 3．3
	19 20	9	0．1 0．05	400 400	1210 1140	57 53	3．0 3．1
	21 22	2	0．1 0．1	570 280	840 990	14 43	3．7 3．4
	23 24	3	0．1 0．1	570 280	910 1060	29 45	3．6 3．3

(Note) Diameter of #10mm -- (99.99%) Diameter of -> 0.1mm (96%) Diameter of ->0.02mm Diameter of diameter [of 10mm]-(99.9975%) ->0.05mm (84%) Diameter of ->0.02mm Sample No.13-20 are an example 1 and sample No.21-24 are an example 2.

[0021]

[Table 4]

分類	試料	合金	焼鈍線径 # mm	焼鈍温度 ℃	引張強さ N／mm²	疲労破断回数×10⁶	伸線性 kg／1断線
比較例1	25 26	2	0．3 0．03	400 400	980 720	33 2．1	1．3 2．8
	27 28	3	0．3 0．03	400 400	1010 760	38 3．3	1．5 2．6
	29 30	4	0．3 0．03	400 400	910 680	18 1．1	1．1 2．2
	31 32	6	0．3 0．03	400 400	870 620	15 0．9	0．8 1．4
	33 34	7	0．3 0．03	400 400	960 730	28 1．8	0．7 1．6
	35 36	8	0．3 0．03	400 400	1070 790	39 3．8	1．9 2．7

(Note) Diameter of diameter-(99.56%) ->of diameter-(99.91%)--> of #10mm 0.3mm 0.02mm Diameter of diameter [of diameter / of 10mm /-(99.9991%) ->0.03mm]-(55.56%) ->0.02mm. [0022]
[Table 5]

分類	試料	合金	焼鈍サイズ # mm 径	焼鈍温度 ℃	引張強さ N／mm²	疲労破断 回数$\times 10^6$	伸線性 kg／1断線
比較例2	37	2	中間焼鈍なし		1050	34	0. 34
	38	3	〃		1060	36	0. 41
	39	4	〃		820	16	0. 22
	40	6	〃		820	14	0. 32
	41	7	〃		840	18	0. 50
	42	8	〃		1010	33	0 37
比較例3	43	10	0. 1	400	920	19	0. 33
	44		0. 05	400	870	14	0. 52
	45	11	0. 1	400	650	1. 0	2. 83
	46		0. 05	400	620	0. 8	2. 52
	47	12	0. 1	400	720	3. 5	1. 4
	48		0. 05	400	620	1. 1	1. 6
	49	13	0. 1	400	810	9. 5	1. 7
	50		0. 05	400	780	3. 3	1. 2
	51	14	0. 1	400	950	18	0. 52
	52		0. 05	400	920	21	0. 44

(Note) Diameter of #10mm -(99.9996%)-------- Diameter of ->0.02mm (with no intermediate annealing) Diameter of 10mm -- (99.99%) Diameter of -> 0.1mm (96%) Diameter of ->0.02mm Diameter of diameter [of 10mm]-(99.9975%) ->0.05mm (84%) Diameter of ->0.02mm. [0023] In having wire drawing nature 3.0kg [per one open circuit] or more, each sample No.1-24 of the example of this invention is excellent also in intensity and the fatigue-proof property, so that more clearly than Tables 2-5 (two or more [800Ns //mm] tensile strength and the number of times of fatigue fracture more than 107 times). On the other hand, example 1 of comparison No.25-36 and example 2 of comparison Since the rate of cold working separated from the convention of this invention, No.37-42 are the example 3 of comparison. Since No.43-52 had few amounts of alloy elements, they were that to which wire drawing nature falls and neither is suitable for practical use. Moreover, thing to which the rate of cold working after the last intermediate annealing exceeded 99% (No.25, 27, 29, 31, 33, 35) The waist is weakly inferior to coiling nature (it does not display), and the aforementioned rate of cold working is less than 80% of thing (No.26, 28, 30, 32, 34, 36). It was inferior to tensile strength and the fatigue fracture property. No.45-50 were inferior in at least one sort of tensile strength and a fatigue fracture property among those for which the amount of alloy elements was insufficient.

[Translation done.]